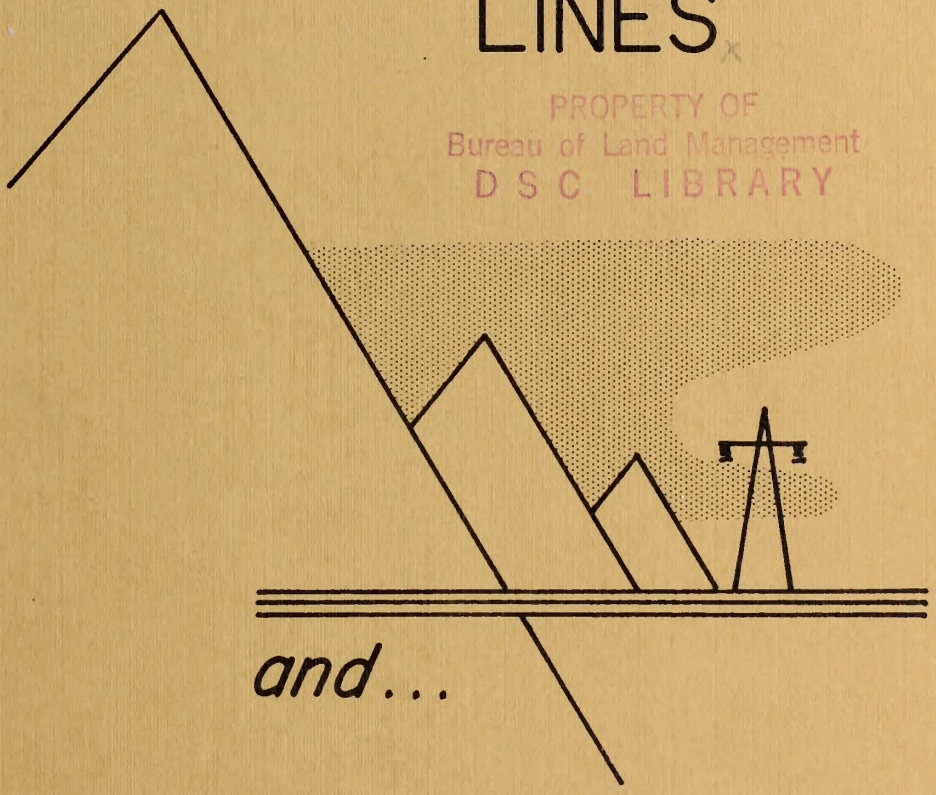
The impact of

POWER TRANSMISSION LINES



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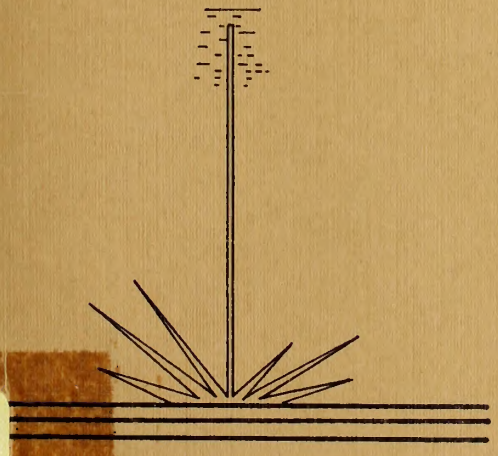
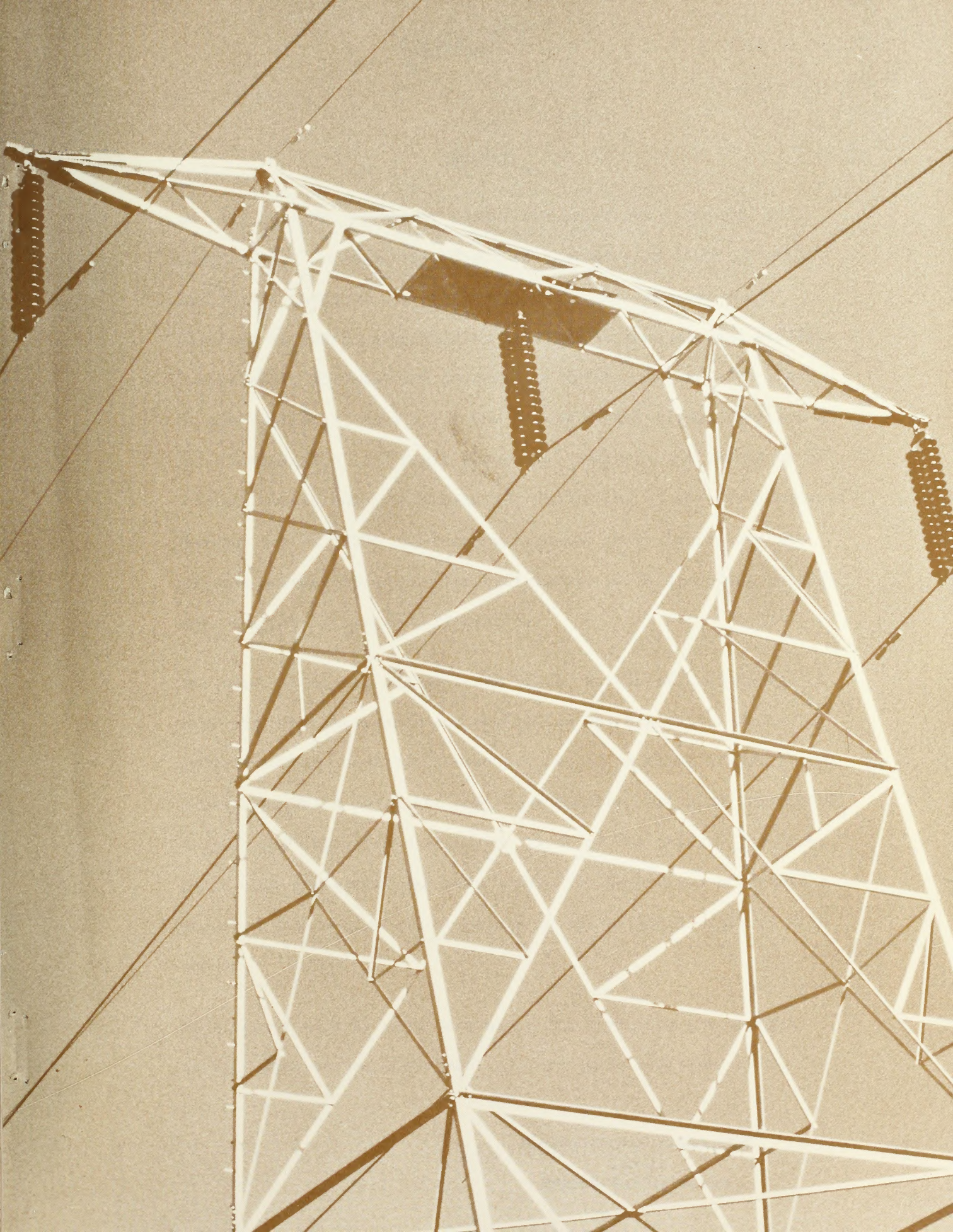


THEIR EFFECT ON THE SOUTHWEST ENVIRONMENT

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SEPTEMBER 1970



PREFACE

On July 1, 1970, Secretary Hickel announced the formation of a special team to study the impact of transmission lines crossing the public lands of the arid Southwest. The team was also directed to draft guidelines to assist land managers and utility companies in planning the location of future transmission lines in the Southwest; make an on the ground review of the location of two transmission line route proposals; evaluate the impact of alternate routes consistent with the provisions of the Environmental Quality Act of 1970; and recommend routes which would have the minimum adverse effect on the environment while providing reasonable electrical system reliability.

The team, initiated and directed by the Bureau of Land Management with the assistance and council of the Bonneville Power Administration, made field observations of existing transmission lines, contacted local and state governments, met with interested groups, and interviewed representatives of the utility industry. Other land management agencies within the Department of Interior supplied information and commented on the original draft of this report.

This report will be used as a basis for review by the general public prior to the Department of Interior's decision on the

right-of-way application filed by the Los Angeles Department of Water and Power and as an indication of the preferred location of the proposal by Southern California Edison to locate a transmission line between the power plant at Bullhead City and the Devers Substation near Desert Hot Springs, California.

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OBJECTIVES OF THE STUDY

1. Determine in general the effect power transmission lines have on land use and the environment of the arid Southwest.

2. Study the Navajo-McCullough and Mohave-Devers proposed transmission line routes as well as projected needs for additional lines from generating plants planned for construction in the region. Analyze alternatives and recommend the most suitable routes.

3. Investigate and draft guidelines that will assist land managers and the electrical utility industry in selecting the most suitable transmission line routes through the Southwest considering environmental protection and the need for reliable electric power.

MAP I

STUDY AREA & NATURAL REGIONS

THE AREA

The study area includes Southern California, Southeastern Nevada, Southwestern Utah and Arizona.

Variations in physical development of the Southwest have made it one of the most unique areas in the United States. Extremes in elevation range from 282 feet below sea level in Death Valley, California to towering peaks in the southern end of the Sierra Nevada Range of over 14,000 feet.

Due to the physical composition of the region, temperatures and precipitation vary considerably. Influences from the Pacific Ocean create mild conditions along the Southern California coast where temperatures average about 55^{o} in winter and 73^{o} in summer. Rainfall averages about 15 inches yearly.

With the exception of some of the higher Sierra areas, the balance of the study area is generally very hot and dry. Some of the desert basins receive as little as two inches annual rainfall with average summer temperatures in excess of 100^{o}.

Native vegetation consists primarily of desert types such as creosote bush, burr sage, yucca and joint fir in the lower elevations while Joshua trees, sagebrush, pinyon pine, and juniper

Typical Nevada desert scene northeast of Las Vegas

Arizona Strip east of the Virgin Mountains

are found at the intermediate elevations. At the higher elevations subalpine species such as ponderosa pine, Douglas fir and quaking aspen are found.

The value and importance of every natural resource, including open space is ever increasing. Today people and industry need and use products of the land that were not even considered a century ago. Open space is a positive and functional land use and should be considered as a major element in the preparation of any land use plan.

Use of the California Desert.
Note power lines in background

Another use of the desert

THE SITUATION

The increasing demand for electrical power in the Southwest has resulted in proposals for new transmission line routes across the desert. New lines must be constructed to transfer power from generating plants being constructed or planned for construction in Northern Arizona, Southern Utah and Southern Nevada to the power markets of Southern California and Southern Arizona. These lines must cross the desert parallel to existing transmission lines or new routes must be provided.

The Southwest has experienced one of the most rapid population increases of any area in the nation. During the period from 1960 to 1970, the population of Southern California increased by about 2,850,000 people. The Southern Arizona and Southern Nevada areas experienced similar growth rate increases during the same period.

With these increases in population, plus higher per capita use of electricity and increased industrial expansion, requirements for electrical energy have grown since 1968 at about 9 per cent per year. This increase is expected to continue through the foreseeable future.

In response to the increased demand and based upon projected energy requirements, electrical generating plants are being constructed

near Page, Arizona and in Nevada across the Colorado River from Bullhead City, Arizona.

Six agencies are participating in the Navajo Power Project at Page. They are the Arizona Public Service Company, Salt River Project, Tucson Gas and Electric Company, Nevada Power Company, Los Angeles Department of Water and Power, and the Bureau of Reclamation.

Three lines will be required to transmit power from the Navajo Generating Station to load centers at Phoenix, Arizona and Los Angeles, California. Two of these lines link the Navajo plant to the Phoenix area. These will follow existing transmission lines and are not considered in this report. The third line will extend from Page, Arizona to the McCullough Switching Station near Boulder City, Nevada. The power will be transmitted from the McCullough Switching Station to Los Angeles over existing lines. The Los Angeles Department of Water and Power (LADWP) has filed preliminary applications for transmission line rights-of-way extending from the Navajo Generating Station near Page to the McCullough Switching Station in Eldorado Valley, south of Las Vegas, Nevada. The LADWP is to construct the Navajo-McCullough 500 KV transmission line. Nevada Power Company will operate and maintain the line.

The proposed route is generally westward across the Arizona Strip and into Nevada near the community of Mesquite and then south to the McCullough Switching Station. No high voltage transmission lines presently cross the Arizona Strip.

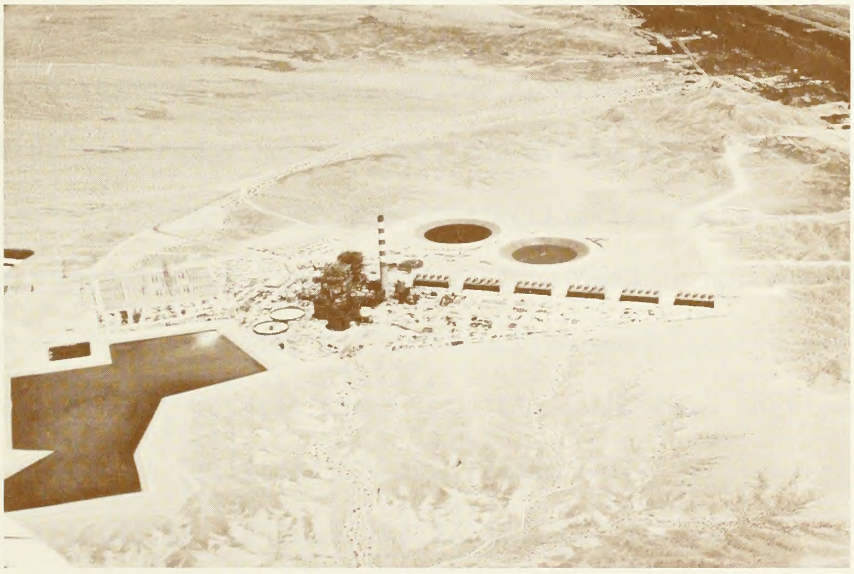
The Mohave Generating Station in Southern Nevada, across the Colorado River from Bullhead City, Arizona is being constructed by the Southern California Edison Company. Initial power production from the plant at Bullhead City will require two 500 KV lines to the Devers Substation, located near Desert Hot Springs, California (see Map 5).

No right-of-way application has been filed by the Southern California Edison Company.

The plants at Page and Bullhead City are but the first of a number of coal fired generating plants projected for construction in this area. The Kaiparowits steam plant is planned for construction north of Page in Southern Utah. This plant will have more than twice the generating capacity of the Navajo plant and will require as many as four additional lines to transmit power to the Southern California load center.

Based upon present technology, the area promises to become increasingly important because it contains the concentration of fuel and

Eldorado Substation and adjacent
McCullough Switching Station



Mohave Generating Station

water resources needed for steam generation of electrical power. The people in the power marketing areas, concerned about air pollution, are also resisting the construction of fossil fuel electrical generating plants in their communities. Further, it is generally considered cheaper to transmit electrical power than it is to ship fossil fuel over equally long distances.

New technology may permit long distance undergrounding of transmission lines in the future and this could help alleviate many of the environmental impacts. Nuclear power plants located near the power load centers could also reduce the need for long transmission lines and help alleviate the environmental problems.

However, technology has not yet been developed to the point where undergrounding is feasible for moving high voltage power over great distances. Decisions on the location of transmission lines must be made today to help meet the ever-growing demand for reliable, uninterrupted flow of electricity. Delaying all construction until new technology is developed is not a realistic alternative. Planning and construction must proceed and land use decisions must be made based upon the assumption that overhead lines will be the means for the transmission of high voltage electrical power for at least the foreseeable future.

IMPACT OF TRANSMISSION LINES ON THE SOUTHWEST ENVIRONMENT AND RESOURCES

Considerations

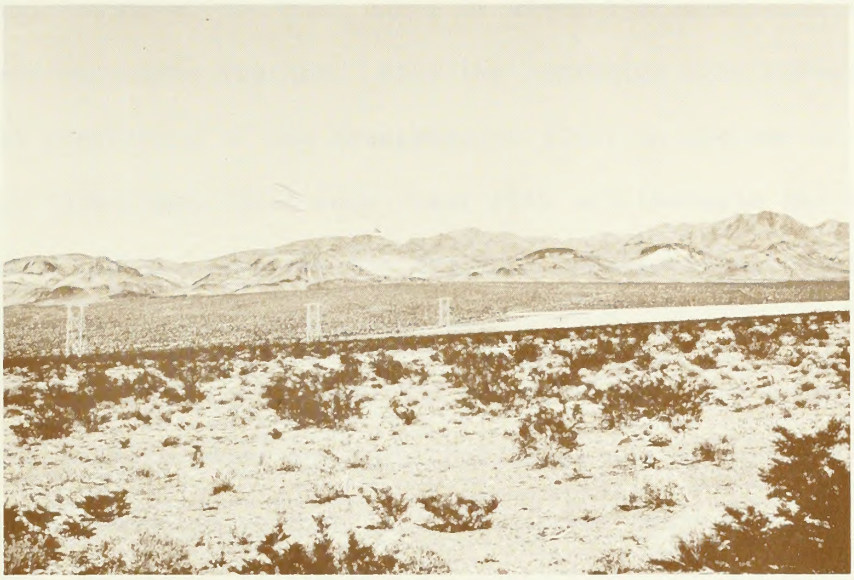
* Open Space - areas of land relatively free from development and having esthetic and natural beauty values. Electric transmission lines have an impact on open space. The first transmission line constructed through an area relatively free from development has the greatest negative impact because it is the first obstruction to mar the landscape. Transmission lines have four major features which have an impact on the landscape. These are the towers, the conductors, the roads required to construct and maintain the lines and, in some areas, the clearing of the right-of-way.

In the desert area of the Southwest, transmission line towers and conductors usually fade from view at a distance of about three miles. The distance varies with light conditions, time of day and angle of the sun.

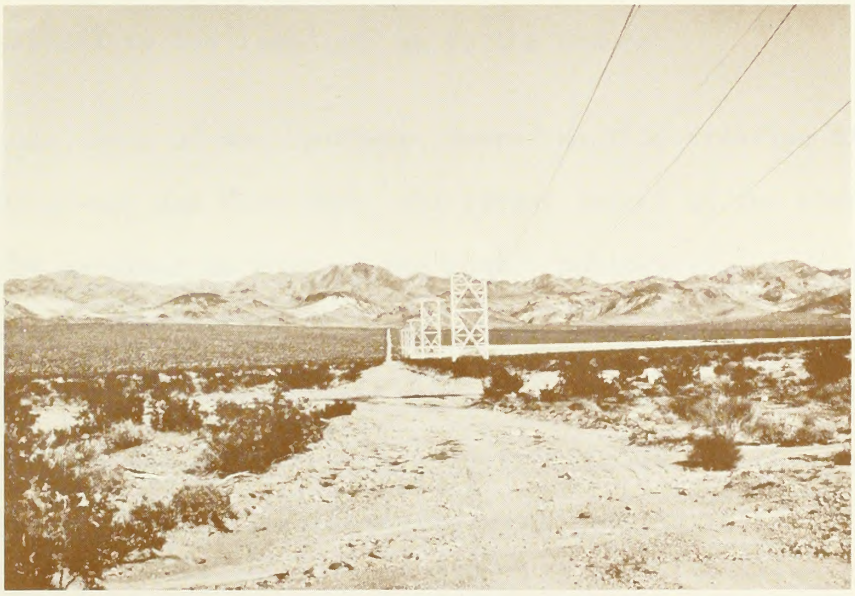
Wooden towers and single poles in the desert usually stand out for much greater distances than steel towers. The lattice construction of steel towers breaks up and diffuses the light and shadows, whereas the full length poles, shaded on one side, do not.

Steel towers fade from view

Wooden poles do not



Unpainted towers beyond the last painted one are not visible against the mountain backdrop. SE of Las Vegas.



Same line. Unpainted towers beyond last painted one are not visible although construction and maintenance road is clearly visible.

In the Southwest the road under or along a transmission line is a most obtrusive feature. From the beginning line survey to final completion of the transmission line, an average of 14 different work crews visit each tower site and traverse the road between towers. Besides the original construction, continuous use of the road indelibly imprints it upon the landscape. In many areas of the Southwest the color, texture and consistency of the surface soils are such that roads are difficult to erase after a transmission line is constructed. Natural color and texture cannot be restored and natural vegetation regrowth is an extremely slow process. Artificial revegetation can also be very slow. The towers and conductors disappear from view but the road can be seen for long distances. It does not fade away or blend into the landscape as do the towers.

In some areas of the Southwest where complete clearing of the right-of-way has been done, the visual impact of the clearing can be as great as that of the road. Fortunately, less and less complete right-of-way clearing is now being done. In arid areas with relatively low-growing vegetation, there is little need to remove natural vegetation on the right-of-way except where necessary for road construction and at the tower pads.

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Three lines - one trunk road.
Towers and conductors disappears from view;
the road and tower pad clearing do not.

Early morning sun reflecting on APS 500 KV line
in Arizona east of the Grand Wash Cliffs.
Right-of-way clearing in Pinyon-juniper.

Three lines - one trunk road.
Towers and conductors disappears from view;
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Early morning sun reflecting on APS 500 KV line
in Arizona east of the Grand Wash Cliffs.
Right-of-way clearing in Pinyon-juniper.

* Wildlife

A wide variety of wildlife is found throughout the study area including: mule deer, desert bighorn sheep, fox, coyote, badger, antelope, bobcat, varieties of squirrels and chipmunks, many species of birds and various snakes and lizards. A rare and endangered species found in the study area is the Gila Monster. Other endangered species include the Desert Tortoise and the band-tailed pigeon.

The overall effect of transmission lines on wildlife is minor. Some experts feel that noise from high voltage transmission lines may act as a temporary barrier to the movement of wildlife. However, it appears that wildlife quickly become accustomed to the lines and noise.

Road construction and clearing of tower sites has an impact on wildlife habitat. It may reduce the total amount of forage and cover. This impact can be important if the amount of forage and cover taken out of production is extensive or in short supply. However, right-of-way clearing in some brush or timbered areas can improve wildlife forage.

Roads associated with transmission lines can have an additional, indirect impact on the wildlife resource. Roads may open up areas

Desert Tortoise

Desert Bighorn Sheep

which were previously not readily accessible by hunters. If the wildlife resource was otherwise underutilized, the road probably has a beneficial rather than a negative effect.

* Outdoor Recreation

In the desert Southwest, transmission lines or utility corridors are not compatible with intensively developed recreation areas. This is also true for those areas identified for future recreation development.

Transmission lines distract from the scenic values of developed campgrounds and other intensive use recreation sites in the open desert or other rural areas and are generally objectionable to recreationists.

With the exception of the impact on open space, transmission lines and utility corridors do not have an adverse impact on general outdoor recreation uses. On public land, the trunk road for a transmission line or corridor is generally open to public use and provides access for many different outdoor recreation experiences.

The sightseer, rockhounder, trail hiker, four-wheeler, motor cyclist, and anyone else seeking a varied outdoor recreational experience can utilize the transmission line road to gain access

into different areas. The towers and conductors, although esthetically objectionable, do not greatly hinder or detract from these varied outdoor recreation uses.

* Soil and Watershed

Soil and watershed values are not adversely affected by transmission line towers and conductors. These values are affected by road construction, tower pad and right-of-way clearing, borrow areas and other soil disturbing construction activities. The effects can be minimized, but the best environmental planning for soil and watershed protection can be reversed or defeated by uncontrolled construction.

* Forage

The primary effect on the vegetative resource by transmission lines occurs on or near the right-of-way. Vegetation is disturbed by the construction and maintenance road, tower footing and pad areas, campsites, storage areas, borrow areas, and other areas where the soil has been disturbed by construction activities.

An average of 3 to 5 acres per line mile may be permanently taken out of production by the construction and maintenance trunk road and tower pads. The significance and the amount of land taken

out of vegetative production will vary with the vegetative type of the country involved -- desert, grassland, etc. Generally, in desert areas, the impact is not great because forage production is low.

The effect of transmission lines on domestic livestock is minor. Cattle will graze under the lines and on the tower pad areas. In some instances the trunk road can be used to check on and facilitate livestock movement and for hauling livestock water in arid regions.

* Minerals

The study area has a variety of minerals, although many are not economical to mine at the present time. The largest mineral operation is the iron mine at Eagle Mountain in California. Large gypsum deposits are being mined in the Las Vegas area. The coal deposits in Southern Utah and Northern Arizona are among the most valuable minerals of the region, and are the source of the fuel for the generating plants being constructed in the area.

Transmission lines and utility corridors do not have an adverse impact on the mineral resource. Rather, a source of power near a valuable mineral deposit can be beneficial in the commercial development of the resource.

* Timber

Very little of the study area can be classified as timber type. Pinyon-juniper occurs in the higher elevations and Ponderosa Pine is found in small isolated areas at the highest elevations such as the Kaibab Plateau and Black Rock Mountain south of St. George. Pinyon-juniper type is also found north of the Williams-Flagstaff area, mostly on the Kaibab National Forest south of the Grand Canyon.

The effect of transmission line rights-of-way in this area is minor because most of the timber is pinyon-juniper and of little commercial importance.

* Historical and Archeological

Evidence of early man is found throughout the Southwest and presents a key to the study of bygone cultures. Two basic cultures which have been located within the study area are the Pueblo in the Colorado Plateau Region, and an early Desert Culture in the Great Basin and Mohave Desert areas. Evidence of Indian cultures of some 20,000 years ago has been found near Las Vegas.

Recent history reveals that Spanish explorers made their way into much of the Southwest in the mid 1500's, followed by further

exploration in the 1700's and 1800's. The Mormon pioneers settled much of Utah, Arizona, and Nevada in the 1850's.

Transmission lines or utility corridors can have an adverse impact on historical and archeological sites. A transmission line passing through an unidentified site could be disastrous because once disturbed the site loses much of its historical significance. As archeological and historical studies have not been made throughout the majority of the area covered by this study, any corridor location or specific line routing must be thoroughly studied before construction begins in order to protect, preserve, or retrieve historical and archeological values.

* Primitive Areas

Although relatively few in number, primitive areas are of special importance in that there is little evidence of man's encroachment. They are usually isolated areas of relatively small acreage which contain unique and diverse features to which people attach special values -- open space, natural beauty, recreation, esthetics, etc. Such areas should be protected from all man-made intrusions. Transmission lines and utility corridors fall into this category. They should not be allowed to cross designated primitive areas or areas qualified for such classification.

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* Natural Areas

Natural areas represent examples of forest, range and aquatic communities and geological features in natural or near-natural conditions. They are usually small in acreage and, to fulfill their purpose, must be protected from all forms of development. Transmission lines or utility corridors must not be allowed to transect such areas.

Summary

Transmission lines have the greatest environmental impact on open space and scenic resources of the arid Southwest. In most cases other resources are not significantly effected.

MAP 2

GENERAL PHYSICAL FEATURES AND MAJOR RECREATION AREAS

TRANSMISSION LINE RIGHT-OF-WAY AS A LAND USE

Electrical Power Needs

Land managers are faced with providing public lands for rights-of-way to facilitate meeting the ever-growing public demand for reliable electrical power while minimizing adverse effect on the environment. The industry is faced with the problem of supplying reliable energy at a reasonable cost when and where it is required.

In the Southwest, the demand for electricity is expected to more than double during each of the next two decades. (See Table 1.)

Table 1

SELECTED WESTERN REGION PEAK
ELECTRIC POWER DEMANDS BY LOAD CENTER

Load Center	Peak Demand 1970	1980 (megawatts)	1990
Los Angeles-San Diego	13,300	27,700	55,000
San Francisco-Sacramento-Reno	11,200	24,100	51,600
Phoenix-Tucson-Las Vegas	4,490	9,570	20,600
Southern Idaho-Utah	2,840	5,690	11,460
Albuquerque-El Paso	1,035	2,180	4,090

Source -- The Future of Power in the West Region. Prepared by the Western Regional Advisory Committee, June 1969.

New electrical power plants that will handle a portion of this demand are:

Plant	Location (near)	Plant Status	Capacity
Mohave	Bullhead City, Arizona	Under construction	1,500 mw
Navajo	Page, Arizona	Under construction	2,310 mw
Kaiparowits	Glen Canyon City, Utah	Proposed	5,000 mw
San Juan	Farmington, New Mexico	Approved	990 mw

The Mohave, Navajo and San Juan plants will cover demands to 1980. The Kaiparowits plant will be needed on-line soon after to meet the power needs of the 1980-90 period. There also is the possibility of other plants being needed during this period.

Power transmission from coal fired thermal plants between 1970-90 will generally be at 500 KV with the possibility that late in the time period large developments will go to 750 KV. About 70 per cent of the demand will be in the Southern California area and the remainder will be in the Phoenix-Las Vegas area. Most of the power going to Southern California will intertie with facilities in the Las Vegas area.

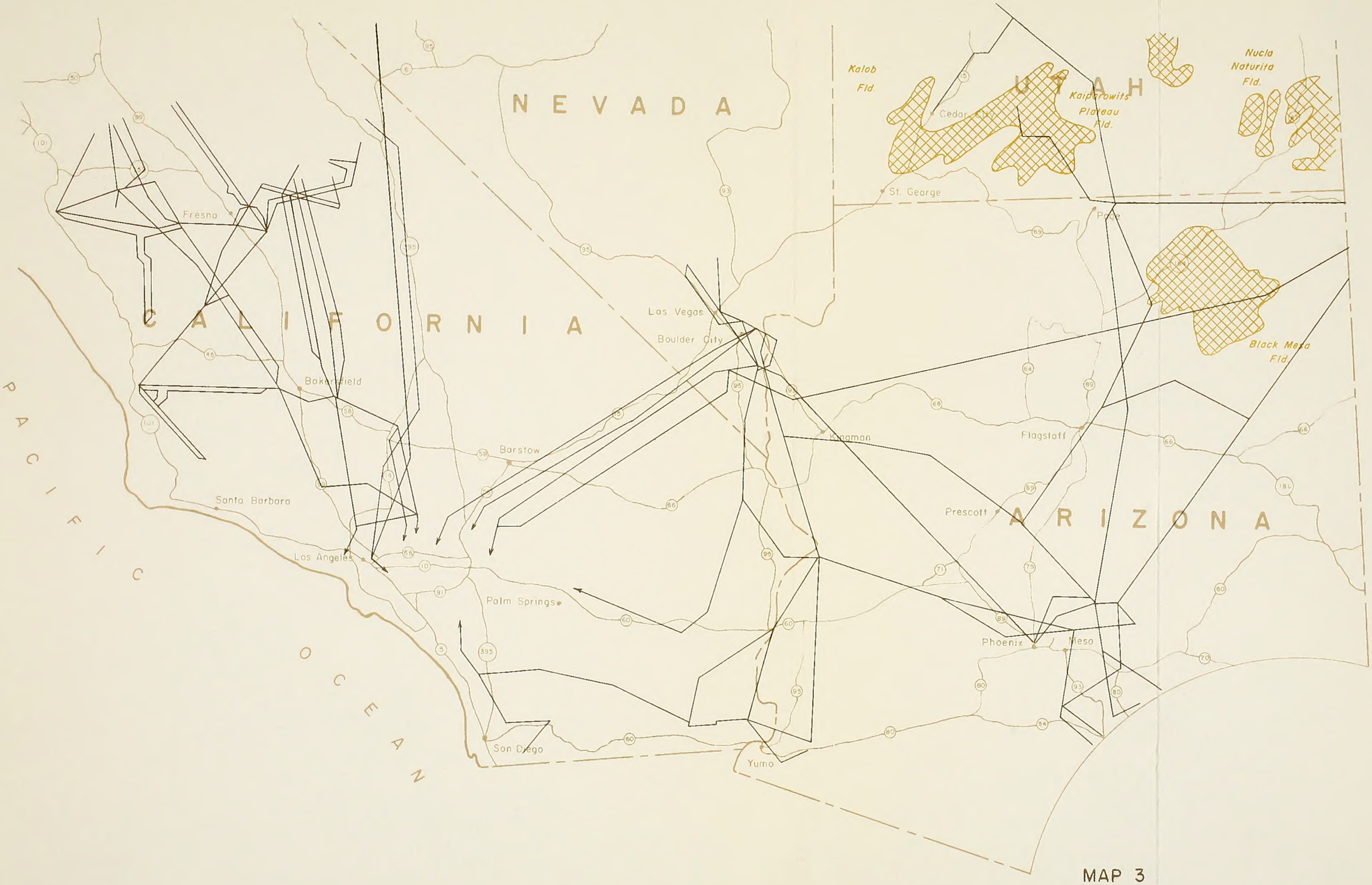
Based on the best information available, the following transmission lines are projected.

Plant Site	No. of Lines	KV	Load Centers
Mohave	5	500	Southern California
Navajo	1	500	Southern California
Navajo	2	500	Phoenix
San Juan	1	345	Tucson
Kaiparowits	2	500	Southern California
Kaiparowits	1	750	Southern California
Kaiparowits	1	500	Phoenix

Kaiparowits transmission lines could number as many as 5 if all are 500 KV.

Use of Land for Transmission Lines

In a 500 KV line of the type under construction, there are usually 3 pairs of conductor cables and 2 overhead ground wires. At normal spacing there are about 4 towers per mile. Each tower is about 110 feet high and occupies about one-half acre. The tower sites and the road required for line construction and maintenance, occupy slightly less than 4 acres per line mile.



MAP 3

MAJOR TRANSMISSION ROUTES AND COAL FIELDS

Corridors

From the standpoint of the widespread impact upon the environment, designated corridors for transmission lines, or transmission lines in combination with communication lines, pipelines or highways are preferred over single lines. However, since corridors cannot be allotted unlimited width, and transmission reliability is improved with multiple routes, more than one corridor through a state or portion thereof should be considered.

Transmission lines are not compatible with communication lines and oil and gas pipelines unless they are sufficiently separated to avoid dangerous currents and voltages during electrical faults and to avoid interference during normal operation. Corridors must be sufficiently broad to accommodate different types of utilities or separate, narrow corridors must be provided.

Single, scattered lines give much greater reliability than two closely paralleled lines and are less likely to interfere with other types of utilities, but single lines in proliferation are more detrimental to the total environment. The system reliability of two closely paralleled lines can be improved through separating segments by several thousand feet or a few miles where hazards are great; thus keeping the environmental impact low.

Corridors should be carefully planned in order to obtain the benefits of compatibility of adjacent utilities, maximum utilization of available space and fewer objections from the general public. In the planning process, consideration must be given to existing utilities, whether they be railroads, communication lines, transmission lines, highways, or pipelines. It must be ascertained whether any are to be expanded in capacity, replaced, or removed. The quantity, type and space requirement for each future utility must also be ascertained as near as possible. All available data should be considered in order to achieve the most usefulness with the least clutter.

Transmission Line Economics and Reliability as Factors in Land Use Decisions

The public is demanding reliable electrical service at reasonable cost.

In terms of "land use," the industry desires the shortest routes with the lowest construction and easement costs. To improve reliability it selects routes that avoid natural hazards and spaces transmission lines widely enough to minimize the possibility that one common cause would result in the simultaneous interruption of a number of lines.

The electric utility industry is placing more emphasis that ever on reliability. Economics, although important, appear to be a secondary consideration. As more emphasis is placed on reliability, the spacing and location of lines becomes more critical. At the same time, it should be recognized that spacing and location are not the only means of improving reliability. Equally important, if not more so, are design and construction standards.

The industry defines reliability as the measure of an electric power system to provide a continuous, uninterrupted flow of power.

Their goal is to protect customers against any loss of service within economic and environmental limitations. The industry

has established minimum criteria for reliability but is not able to quantify in a statistically valid manner the increased reliability that a particular means will provide. There are too many unpredictable variables that must be accounted for.

Decisions concerning reliability are based largely on judgment factors. The industry considers it prudent system design practice to widely separate transmission lines and limit the number of lines on one route or right-of-way corridor.

The key to the transmission line location problem is to find the route that will minimize the impact on the environment while still providing a suitable route from the standpoint of providing reliable electricity.

In order to find this optimum alternative it is necessary to evaluate the environmental impacts of alternative transmission line routes against the economic and reliability factors. It is possible to calculate the difference in cost of alternative transmission line routes but it is impossible with the present methodology to quantify in dollar terms the environmental values to be given up or protected.

Since industry is not able to precisely quantify reliability, and environmental values cannot be evaluated in dollar terms,

it is impossible to calculate whether the amount of reliability to be given up by selecting one alternative over another is worth more or less than the environmental values to be protected.

At this time, it is possible only to provide broad statements on the relative environmental values to be protected or lost, and statements that one alternative would provide more reliability than another.

Therefore, selection of the most suitable route must be based on a judgment of the general significance of environmental values to be protected, compared to the relative loss in reliability and the general magnitude of the added costs.

Also, conflicts between environmental protection and transmission line reliability and cost can be minimized by adherence to environmental criteria and minimum reliability criteria. One way of accomplishing this objective may be to establish transmission line corridors.

Corridors are considered by the study team to be strips of land of undetermined width within which utilities are located. They may vary in width from several hundred feet to several miles.

Designation of a corridor for transmission lines may increase the total acreage of land designated for right-of-way use, but the

confining of transmission lines to a corridor will minimize their total impact on open space. In the Southwest desert, however, the most important impact that corridors may minimize or eliminate is the intrusion of transmission lines into vast open desert areas. By placing all lines in one or two corridors the intrusion of transmission lines into the balance of the desert area is effectively eliminated.

The corridor approach is most feasible when the number of lines in the corridor is limited. Too many transmission lines concentrated in one area can contribute substantially to visual pollution. Also, a large number of lines in one corridor makes it more difficult to screen them from sight and avoid adverse effects on the environment.

The corridor approach must also accommodate transmission system reliability at all stages of development. Use of corridors increases the possibility that one common cause could simultaneously interrupt a number of transmission lines. According to industry this can partly be guarded against by placing individual lines or pairs of lines at least 2,000 feet apart in a corridor.

The initial stages of transmission system development are critical because there are few lines. If initially two transmission lines

are associated with a power plant, it is industry's recommendation that each line be provided a separate corridor. This guards against the loss of the entire system from one common cause such as storm, vandalism or sabatoge.

GUIDELINES TO MINIMIZE THE IMPACT OF TRANSMISSION LINES ON THE ENVIRONMENT

In the selection of a transmission line route or corridor in the Southwest, the following guidelines will aid in safeguarding environmental values within the constraints imposed by the current state of high voltage transmission technology. These guidelines are adapted from the United States Department of the Interior's Environmental Criteria for Electric Transmission Systems; A Report on Appearance Planning, Bonneville Power Administration, May 1966; BLM Manual 2031, Environmental Quality and Natural Beauty; and observations of the study team.

* Rights-of-way should be selected to preserve the natural landscape and minimize conflict with present and planned uses of the land on which they are to be located.

* Retire or upgrade existing lower voltage transmission circuits, where possible, to allow construction of higher capacity circuits on existing rights-of-way, thus cutting down on the total number of lines.

* Properly sited established rights-of-way should be used where warranted for the location of additions to existing transmission facilities. After an initial transmission line has been constructed through, or partially through, a heretofore

relatively undisturbed area, additional parallel lines do not have as great an impact on the landscape. The same right-of-way or corridor should be used and the initial road should be used to the extent possible for construction and maintenance of the additional lines. Spur roads from the trunk (initial) road can be provided to each construction site and, after completion, restored as near as possible to its original condition. The environmental advantage of minimizing the number of roads is obvious.

* The joint use of rights-of-way with other types of utilities should be coordinated in a common corridor wherever uses are not incompatible.

* Avoid constructing a line along the top of a range of hills, especially when it is visible from a highway, body of water, or populated area. Valleys, canyons and draws should be used.

* Avoid the sky as a background for transmission towers. Visibility of the towers and conductors is further reduced when the line is located against a natural background as seen from the major view area. Tower design, painting, or dull, non-reflective finishes for towers and conductors still further reduce visibility. Painting, although expensive, should be required at locations such as highway and river crossings where

towers are most visible. Nonspecular lines are being manufactured in order to reduce reflections and visibility. Other aids to minimize the visual impact of towers and conductors are camouflaging by integrating, blending and concealing with surroundings and by developing esthetically appealing structures which, because of their appearance and form, will be acceptable to the public.

* If a transmission line must be routed near developed recreation sites, adequate buffer areas, either open space or natural vegetative or topographic screening should be utilized to minimize the visual impact. If this cannot be done, the feasibility of placing the line underground should be clearly determined.

* If a transmission line or utility corridor should have to pass on the periphery of a primitive area, it should be separated from the area by an open space buffer, a vegetative buffer or by natural terrain.

* Avoid long views of transmission lines coming down hillsides adjacent to a road or highway.

* Transmission lines should cross roads or highways between high points, at a dip, or on a curve in the road.

* Where a line route is near a road or highway and parallel to it, the line should be screened from view by natural terrain or vegetation as much as possible.

* At road crossings of two or more circuits, and where only a portion is visible from the road, lines should be grouped together on double circuit towers to narrow the corridor width at the crossing.

* In relatively low-growing timber types, the only natural vegetation which should be removed from the right-of-way is that which poses a hazard to the transmission line or must be cleared for the trunk road.

* In forest areas, long span towers should be used to allow the retention of the major part of the vegetative growth standing in the right-of-way adjacent to the road or highway. As much of the right-of-way should be left in its natural state as far back from the road as possible.

* In heavily timbered areas where more timber has to be cleared, right-of-way tunnels should be avoided. Where in public view, long straight stretches should also be avoided. All vegetation not causing a safety hazard should be left as undisturbed as possible.

* Rights-of-way should not cross hills and other high points at the crests. The profile of the facilities should not be silhouetted against the sky.

* In timbered areas only those trees which constitute a hazard to the transmission line or which will interfere with line stringing should be removed.

* Clearing and grading of construction areas such as campsites, storage areas, setup sites, etc., should be minimal. These areas should be graded in a manner which will minimize erosion and conform to the natural topography.

* Borrow areas, if needed, should be located away from public view. They should also be restored to such condition that erosion will be avoided and appearance is acceptable.

* Roads should not be constructed on unstable slopes. When constructed, roads should be provided with side drainage ditches and culverts to prevent erosion. They should also be constructed to "fit" the terrain so that excessive cutting and filling is avoided and esthetic values protected. Meandering the road on the right-of-way, taking advantage of natural terrain and vegetation, reduces the visual impact.

* Terraces and other erosion control devices should be constructed where necessary along rights-of-way to enhance soil and watershed protection.

* Steep slopes should be avoided on spoil piles and the tops should be rounded to retain moisture and prevent erosion.

* Soil which has been excavated during construction should be evenly backfilled onto the cleared area or removed from the site. It should be replaced so as to conform with the terrain and adjacent land.

Recommendations:

1. Appropriate stipulations to protect the integrity of the environment must be an integral part of any construction permit. If the criteria identified in "Environmental Criteria for Electric Transmission Systems," and other guidelines are adhered to, the protection of the environment will be secured.
2. Pre and post-location conferences are key elements to assure that the environment will be protected. Once all affected interests have been identified and appropriate measures have been agreed upon to accommodate these interests, a pre-construction conference should be held to clarify the details of the agreements. A similar post-construction conference should also be

held following a physical inspection to assure that these agreements have been completed, and if not, what can be done to rectify any inconsistencies.

3. Close field surveillance by a representative of the land managing agency is paramount.

THE NAVAJO-McCULLOUGH PROPOSED TRANSMISSION ROUTE

The Situation

The Los Angeles Department of Water and Power has filed a preliminary application for a 500 KV transmission line right-of-way extending from the Navajo Generating Station near Page, Arizona, to McCullough Switching Station in Eldorado Valley south of Las Vegas, Nevada. The proposed route is generally westward across the Arizona Strip in the northwestern part of the state, into Nevada near the community of Mesquite, then southwest and south to its terminus. The proposal envisions two transmission lines, one to be completed by 1974, the other at some undetermined time depending on projected generating facilities in the Lake Powell region, such as the Kaiparowits plant which would have about twice the capacity of the Navajo.

No extra high voltage (EHV) lines presently cross the Arizona Strip. Conservation groups and Mohave County officials in Arizona have expressed opposition to LADWP's proposal to construct a transmission line through this open space area. They request that the line should be located in existing corridors.

Two other 500 KV lines from the Navajo plant are proposed. They would extend south to Phoenix and share a route already occupied

by two 345 KV lines which originate at Glen Canyon Dam. These lines would cross a 500 KV line extending from the Four Corners Generating Station near Shiprock, New Mexico to the Eldorado Substation in Nevada. The lines cross near Cameron, Arizona.

The possibility exists of routing the Navajo-McCullough line south from the Navajo plant to Cameron and from there west to McCullough Switching Station parallel to the existing line from Shiprock. The switching station is adjacent to Eldorado Substation.

The Navajo-McCullough study area covers both the "north" and "south" route possibilities.

Boundaries of the study area are loosely defined by Lake Powell and Flagstaff, Arizona on the east, and Southern Nevada's Clark County on the west.

None of the possible transmission line routes discussed are fixed locations. They represent strips of land within which a line could be located. Within each strip there is considerable latitude for actual line location, depending on local resource values and construction problems.

Most of the lands of the study area are publicly owned.

The Forest Service of the Department of Agriculture administers the National Forest lands; National Parks, National Monuments, and National Recreation Areas are administered by the National Park Service; and public domain lands are under the jurisdiction of the Bureau of Land Management.

The study area surrounds the Colorado River gorge. The scenic and recreational complex based on the gorge begins near Moab, in southeastern Utah, with Canyonlands National Park and ends 500 miles downstream at the south end of Lake Mead National Recreation Area. Included are Glen Canyon National Recreation Area, Marble Canyon National Monument, Grand Canyon National Park and Grand Canyon National Monument. Much of the complex is inaccessible, except from the Colorado River and its 3 major impoundments, Lakes Mead, Mohave and Powell.

The National Park Service at Lake Mead National Recreation Area (LMNRA) objects to any new transmission lines crossing the LMNRA unless the new lines are placed on existing towers, redesigned if necessary. A network of lines already exists from the hydro-electric generators at Glen Canyon and Hoover Dams. The 500 KV line from Farmington, New Mexico, crosses LMNRA south of Willow Beach near Boulder City, Nevada. LMNRA is also crossed east of the river by a 345 KV line from Hoover Dam to Phoenix.

Kaibab National Forest lands border Grand Canyon National Park on the north and south. Public domain lands predominate north and west of the Colorado River core, except for extensive areas of private lands in the Las Vegas Valley. The Navajo Indian Reservation is on the east side of the study area. West of the National Forest lands and south of the Colorado River are the large Hualapai and the smaller Havasupai Indian Reservations. Between the Hualapai lands and Kaibab National Forest are broad reaches of lands that are owned by the State of Arizona and by private individuals and organizations. West of the Hualapai to LMNRA the lands are checkerboard; alternate sections are privately and publicly owned. Most of the private lands are owned by the Southern Pacific Land Company. Some of the lands south of the Colorado River are being developed for desert homesite communities.

* North Route

Route A

The route under preliminary right-of-way application of the LADWP is about 260 miles long. It was proposed by LADWP after informal discussions and joint ground examinations with representatives of the Arizona Strip and Las Vegas BLM Districts. It is designated Route A as shown on Map 4.

From Navajo Generating Station, Route A goes northwest after crossing the Colorado River gorge just below Glen Canyon Dam. It remains south of US 89 and parallels two low voltage power lines into Utah and across the uppermost end of Paria Canyon. After crossing Paria Canyon, Route A leaves the existing lines by turning southwest and re-entering Arizona.

At the southeast corner of the Kaibab Indian Reservation the route swings westward through the broad swale of Pipe Valley about 4 miles south of Pipe Springs National Monument. As seen from the Monument, the line would be below the horizon and at least 4 miles distant. It would also be distantly visible for a few miles from Arizona State Route 389.

A possible alternate route north of Pipe Springs was examined and rejected. A line on this alternate would pass through

rough, colorful rock formations, be visible on the skyline from Pipe Springs, and visually intrude on a Utah State Park and a BLM recreation site.

From Pipe Valley Route A continues westward across the Uinkaret Plateau through the Arizona Strip. It remains near a dirt road known locally as the Navajo Trail. The route drops off the plateau over the 1,200-1,400 feet high Hurricane Cliffs at the road crossing.

The terrain west of the Cliffs is rougher than that of the Uinkaret Plateau, and pinyon pine and juniper, mostly absent on the plateau, cover many of the hillsides.

The route passes through four inventoried BLM recreation complexes west of the Hurricane Cliffs. Route A roughly parallels the unimproved Limekiln Canyon road for nearly 30 miles, crossing it at a number of places. It follows the road over the Virgin Mountains and down Limekiln Canyon to its mouth where it enters the arid, sparsely vegetated desert of Southern Nevada.

The route passes westward across the alluvial fans on the north front of the Virgin Mountains and crosses the Virgin River and Interstate 15 between Mesquite and Bunkerville, Nevada. This section of the proposed route is visible both from the highway and from Mesquite.

Arizona Strip looking northeast toward Kaibab Indian Reservation and Pipe Springs National Monument.

Hurricane Cliffs looking north into Utah

After the Interstate Highway and river crossing, Route A follows and generally remains a mile or more north of I-15 to a point a few miles east of Apex siding on the Union Pacific Railroad north of Las Vegas. Along this section the transmission line would in places be visible from I-15. Low hills and shallow valleys would serve to completely screen sections of the line from the highway.

Near Apex the route swings south, crosses I-15 and passes along the eastern front of a low range of hills to Frenchman and Sunrise Mountains east of Las Vegas Valley. The route crosses the historic Old Spanish-Arrowhead Trail north of Sunrise Mountain. It also crosses Lake Mead Boulevard which leaves Las Vegas Valley between Sunrise and Frenchman Mountains and is a main access road to LMNRA. It continues south on the east side of the mountains between LMNRA and the colorful rock formations of an area locally known as Rainbow Gardens.

The route enters Las Vegas Valley a few miles east of the City of Las Vegas southeast of Frenchman Mountain. A number of existing transmission lines traverse that portion of the valley, as does the major water pipeline being built for the Southern Nevada Water Supply Project. Near Las Vegas Wash the route crosses another main LMNRA access road from the Henderson area.

The route continues south along the west front of a low range of hills to cross US 95 east of the City of Henderson. South of the highway the route crosses the mountain pass used by the high pressure gas pipeline west of Railroad Pass. From here it continues south through the mountain valley to McCullough Switching Station in Eldorado Valley.

Route B

Route B, about 275 miles long, is the same as Route A westward from Page to the vicinity of Moonshine Ridge on the Uinkaret Plateau west of Pipe Valley. Here it separates from Route A and heads northwest to cross the Hurricane Cliffs nearly on the Utah-Arizona boundary.

The route continues northwest from the Cliffs through rolling, broken desert terrain. St. George and Hurricane, Utah are to the north and BLM's inventoried Arizona Strip mountain recreation complexes are to the south. The transmission line would be far enough from the mountains and the developing urban communities to create little impact on either area.

Route B follows the northern border and avoids the central portion of the Arizona Strip.

Route B crosses I-15 and the Virgin River above the rugged, colorful Virgin River Canyon. Topography would screen the line at the highway crossing, with no more than four towers visible.

Northwest of the river the route crosses the Beaver Dam Mountains. The pass through which US 91 crosses was examined as a possibility. It was rejected since a transmission line would interfere with the transmission and reception of a major telephone microwave station just south of the road. Route B uses the pass and valley south of US 91.

At the western foot of the mountains the route passes south of an area proposed by Utah BLM as a Joshua Tree National Area and crosses US 91 into the desert terrain characteristic of Southern Nevada.

From the road crossing the route continues southwesterly across the Tule Desert, crosses Beaver Dam Wash and enters Nevada a few miles north and completely out of sight of I-15 and the community of Mesquite.

Route B rejoins Route A north of I-15 between Mesquite and Glendale. From this junction, Routes A and B are identical to McCullough Switching Station.

* South Route

Route C

Route C is already being used by existing transmission lines. It is about 285 miles long. Two 345 KV lines occupy it south from Page to near Cameron, Arizona and continue on to Phoenix. It crosses the high Colorado Plateau desert of the Navajo Indian Reservation as far as Cameron, where it joins an east-west route occupied by a 500 KV line from Four Corners Generating Station to Eldorado Substation. A few miles west of Cameron, Route C passes from the Navajo Reservation and crosses the south end of a part of Kaibab National Forest. It crosses State Highway 64-180 just before leaving the Kaibab National Forest and continues westward across a high, rolling plateau of grassland and interspersed pinyon-juniper woodland for nearly 70 miles to a point north of Peach Springs, Arizona. From the Forest to the Peach Springs area most of the land is in private or state ownership.

Near Peach Springs the existing 500 KV line and Route C turn northwest to cross the southwest corner of the Hualapai Indian Reservation. After leaving the Hualapai Reservation the route passes through checkerboard lands in which alternate sections are privately and publicly owned. It crosses the Music Mountains and drops over

the Grand Wash Cliffs into Hualapai Valley and enters arid desert typical of westernmost Arizona, Southern Nevada and Southern California. The route then crosses LMNRA and the Colorado River about midway between Hoover and Davis Dams. Beyond the LMNRA western boundary it swings northwest to Eldorado Substation and the adjacent McCullough Switching Station.

Route D

Route D is about 340 miles long. It is identical to Route C to a point northeast of Peach Springs, Arizona. Route C continues westward; Route D turns southwest across lands presently unoccupied by transmission lines or other utilities. In Round Valley, east of Kingman, it joins a 230 KV line which extends from Davis Dam to Phoenix. Route D follows this existing line westward to Davis Dam. Between Peach Springs and Kingman the route crosses checkerboard state and private lands. The terrain is rolling upland with interspersed pinyon-juniper and grassland. Route D crosses I-40 and passes a few miles south of Kingman and crosses the Black Mountains a few miles south of Union Pass. The pass is occupied by State Route 68. West of Kingman is arid desert and checkerboard ownership similar to that of the north along Route C. Parts of this section of the

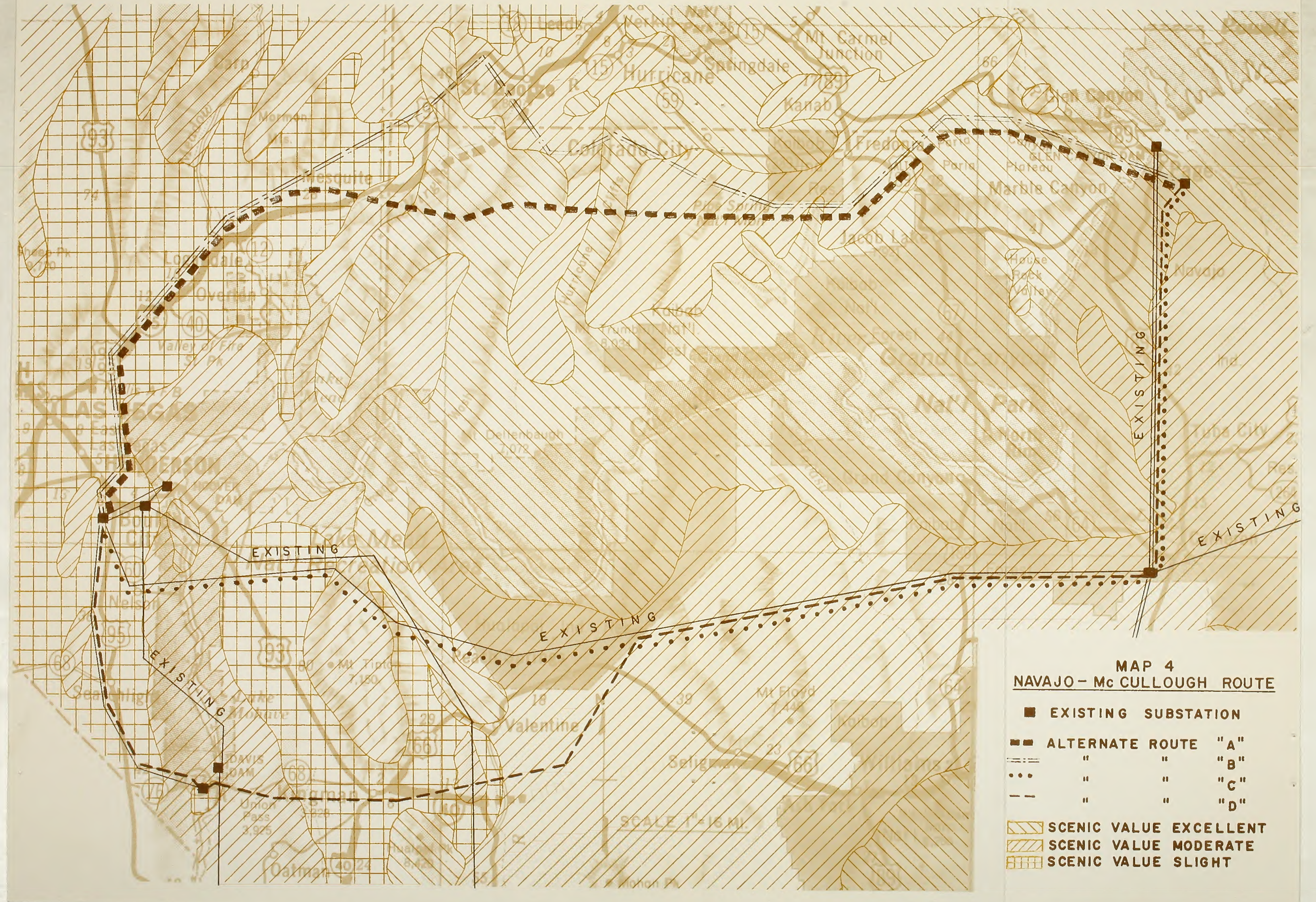
Pinyon-juniper clearing along APS 500 KV line
east of Grand Wash Cliffs

APS 500 KV line looking west toward
Colorado River crossing, LMNRA

route include the coal pipeline from the Navajo Reservation to Mohave Generating Station, and 3 natural gas pipelines.

Route D crosses the Colorado River into Nevada near Bullhead City, Arizona, a few miles south of Davis Dam and LMNRA. The route to this point is about 280 miles long.

On the Nevada side of the river the route turns northward. It follows an existing 500 KV line from the Davis Dam area to Eldorado Substation. The route passes northwest between US 95 and the mountains west of LMNRA, crosses US 95 north of Searchlight and ends at McCullough Switching Station. The high pressure natural gas pipeline to Las Vegas shares part of this section of the route.



MAP 4
NAVAJO – Mc CULLOUGH ROUTE

- EXISTING SUBSTATION
- ALTERNATE ROUTE "A"
- " " "B"
- " " "C"
- " " "D"
- SCENIC VALUE EXCELLENT
- SCENIC VALUE MODERATE
- SCENIC VALUE SLIGHT

Analysis and Discussion

The area offers two broad alternatives. One, to establish a new corridor north of the Colorado River and the other to follow an established corridor south of the river. Both broad alternatives were explored as well as alternatives along the north route and alternatives along the south route. In examining the various alternatives, consideration was given to topography, land uses, impact on environment, impact on resources, impact on long range management plans and objectives and the need expressed by the utility industry for transmission line system reliability.

Combined Route A and B would create little additional impact across Glen Canyon National Recreation Area since it would follow a corridor already in use by two lower voltage transmission lines. Its impact on Paria Canyon Primitive Area would be kept to a minimum since the line would cross the canyon at the uppermost end near an existing transmission line.

A sensitive situation exists along the Pipe Valley traverse. This section of the transmission line would be distantly visible from Pipe Springs National Monument. One of the attractions of the Monument is its broad, sweeping southward view across Pipe

Valley to the Kaibab Plateau. However, the transmission line would be at least 4 miles away, its visibility considerably lessened by distance and no part of it would be skylined.

Between the Pipe Springs area and the western part of the Arizona Strip, Route A traverses broad sweeps of open lands relatively uncluttered except by dirt roads and by BLM range seeding projects where large tracts of pinyon-juniper woodland have been cleared. In crossing the 90 mile long Hurricane Cliffs the transmission line would intrude on a vista bisected only by three dirt roads. A transmission line crossing the Cliffs farther south would approach the colorful Colorado River gorge and Grand Canyon National Monument.

In the western portion of the Arizona Strip Route A would intrude upon the open area of the Arizona Strip, four BLM recreation complexes, and on the rugged scenery of Limekiln Canyon in the Virgin Mountains. It would be highly visible from a number of proposed recreation sites and scenic overlooks.

For these reasons, an alternate Route B was explored. Route B follows the north border and avoids the open space of the Arizona Strip. It also avoids the sensitive recreation complexes in the Virgin Mountain area. It lies closer to developing urban areas,

but still not so close as to be a significant intrusion. Route B would cross the north end of the Hurricane Cliffs and pass through an area already disturbed by roads and prospecting. The route circles through Washington County, Utah, southwest of St. George, then through the Beaver Dam Mountains in the extreme northwest corner of Arizona and into Nevada. In this area, Route B would be invisible from I-15 and the communities of Mesquite and Bunkerville. In contrast, Route A in this area would be highly visible coming down the northwest front of the Virgin Mountains.

Routes A and B rejoin near Glendale and are the same from there to McCullough Switching Station. The line's entry into Nevada is controlled by the acceptability of the corridor through Arizona. Once in Nevada, topography and land use plans leave little leeway for route adjustments. The Mormon Mountains are a north barrier in the Mesquite-Glendale area. The Virgin Mountains-Gold Butte-LMNRA region, and Valley of Fire State Park form a southern barrier. The route is between the barriers.

The southward turn near Apex is largely controlled by the intensely urbanized Las Vegas Valley. The Apex turn allows the line to pass east of Las Vegas Valley and be screened from it by the barrier of Frenchman-Sunrise Mountains for most of its passage around the

Valley. There is no choice, however, south of Frenchman Mountain where the line must enter the southeast corner of the valley. Its impact on that portion of the valley is minimal since there are already a number of transmission lines crossing the area.

The transmission line would be a new surface intrusion through the pass west of Railroad Pass. The valley it would traverse to McCullough Switching Station is occupied only by a gas pipeline.

This segment would not be visible from Eldorado Valley or US 95. Railroad Pass was considered a possible route, but it is narrow and is already occupied by a transmission line and by US 95. The line would not enter the valley until almost to McCullough Switching Station.

South Route C follows existing transmission lines the entire distance from Navajo Generating Station to McCullough Switching Station. Additional lines in the corridor already established would create little new impact along the corridor. However, the National Park Service considers additional transmission lines across LMNRA south of Hoover Dam completely unacceptable, unless the lines are hung on existing towers, redesigned if necessary.

Route D also follows these existing transmission lines to near Peach Springs, Arizona where Routes C and D separate. The 25

miles between Peach Springs and Round Valley east of Kingman would result in the establishment of a new corridor. However, the impact of the new section would be slight, for this new section is already occupied by state and interstate highways, a coal slurry pipeline, and oil and gas pipelines.

Route D would cross the Colorado River below Davis Dam and outside of LMNRA.

The following summarizes the estimated lengths of the four routes under consideration:

Route A	260 miles
Route B	275 miles
Route C	280 miles
Route D	340 miles

Industry reports that 500 KV transmission lines cost about $125,000 per mile. Using this figure the study team estimates the costs of the alternative routes to be:

Route A	$32,500,000
Route B	34,375,000
Route C	35,000,000
Route D	42,500,000

The route that provides the greatest electrical system reliability cannot be precisely determined. This is largely dependent on the total number of lines that will ultimately occupy the various routes.

Either Route A or B would provide greater reliability for the total system than Route C or D because a new transmission line in either of the northern routes would not parallel existing lines. Once one of the northern routes is used and a north corridor is established, either the north or south corridor would provide equal reliability.

If only the Navajo Generating Station and Navajo-McCullough transmission line was involved, the reduced reliability of using the existing corridor would not outweigh the environmental impact of establishing a new corridor. However, construction of the 5000 mw Kaiparowits Generating Station will require at least four additional lines to cross through the study area. In addition, expansion of the San Juan and Four Corners plants in New Mexico may require additional lines through Route C. The confinement of all of these lines into the existing corridor (Route C) would seriously jeopardize the reliability of the total transmission system and would also require a wide corridor filled with many parallel lines and structures. The total impact of this

large corridor upon the environment would be greater than the separation of lines into two smaller widely spaced corridors.

Conclusions and Recommendations

After considering all of the data collected concerning the impact on the environment, reliability requirements of electrical systems, projected power requirements, and power generating sources, the study team concludes that two utility corridors are required through the Arizona-Nevada portion of the study area. The team recommends that Routes B and C be established as corridors between the power sources and load centers.

Power production from existing, under construction, and planned generating stations may require as many as 10 or more 500 KV lines to supply power to the Los Angeles Basin and Southern Nevada load centers. Ten or more transmission lines in one corridor, especially in scenic, heavily traveled recreation areas, would have a serious adverse environmental impact. Use of the existing corridor by this number of lines would not minimize the environmental impact nor would it provide the degree of reliability required for system stability.

Of the four routes considered, Route A, the route proposed by LADWP, would cross a large expanse of relatively undeveloped public land on the Arizona Strip. The open space and scenic

values would be seriously affected by the establishment of a utility corridor through this portion of the study area.

Routes B, C, and D each have an impact on the environment but to a much lesser degree than Route A.

Route B would also cross a portion of the Arizona Strip. But, because of its northerly routing it would miss the wide, scenic expanse of the Arizona Strip. It would pass through areas already disturbed and be far enough away from St. George and Hurricane, Utah, so as to create little environmental impact on either area. Shortly after entering Nevada, it would be in an area already occupied by transmission lines.

Route C is already in use between Page and Cameron, Arizona, and on west to the Eldorado Substation and adjacent McCullough Switching Station. With present restrictions placed on crossing LMNRA by the National Park Service, the total number of lines that can occupy this part of the corridor is limited. Additional use of Corridor C, with the limitations at LMNRA, will not have a serious adverse environmental impact.

When the Corridor C crossing at LMNRA is fully occupied, the study team recommends that Corridor D be utilized. After separating from Corridor C, a new corridor would be established between the

separation point northeast of Peach Springs and Round Valley. However, this general area is already occupied by a coal slurry pipeline, oil and gas pipelines, and highways. From Round Valley, the corridor follows existing lines to Davis Dam and on to the terminus in Eldorado Valley, by-passing LMNRA. The environmental impact of Corridor D would not be significantly increased as most of the route is already in use and away from highly scenic and populous areas.

THE MOHAVE-DEVERS PROPOSED TRANSMISSION ROUTE

The Situation

Southern California Edison Company is completing construction of the Mohave Generating Station across the Colorado River from Bullhead City, Arizona. The primary purpose of the plant is to supply electrical power to the Los Angeles Basin load center. The Edison Company will initially construct two transmission lines (Mohave 1 & 2) between the plant and the existing Devers Substation near Desert Hot Springs, California. These are planned for completion during 1974. The Mohave plant is designed so that additional generating units can be added as the need arises. The projected needs of the Los Angeles Basin load center in the next ten to twelve years indicates the additional units at Mohave will be needed and five additional 500 KV lines will be required to transport the power.

The Edison Company has not filed a right-of-way application with BLM, although it has been working informally with BLM on route proposals. The primary Edison Company route proposal from Mohave to Devers is listed as Route A on Map 5. This proposal would create a new utility corridor through a relatively undisturbed and undeveloped stretch of desert from the Ship Mountains south-

east of Cadiz, California to the Amboy road near the southeast corner of the Twentynine Palms Marine Base. From about this point on through the Twentynine Palms, Joshua Tree, Yucca Valley and Morongo Valley areas the desert is extensively developed for urban and rural retreat areas.

Edison Company's proposal to route two transmission lines through this desert urban area has met with considerable opposition from residents of Twentynine Palms, Joshua Tree, Yucca Valley and Morongo Valley.

This area is restricted from expansion by the military reservation (Marine Base) on the north and the Joshua Tree National Monument on the south. Except for the Morongo Valley area, the proposed line would cross over terrain that is characterized by gentle slopes and rolling hills.

The area has an unusual landscape of Joshua trees and yuccas, interspersed with manzanita, juniper, catsclaw and a variety of cacti and wild flowers. It is used predominately for rural retreat areas and homesites. San Bernardino County's General Plan suggests that rural retreats and homesites are highest and best uses of the land. Their long range planning also calls for consideration of recreation sites, community parks and open space areas in the development of the areas.

Many of the scattered parcels of public land throughout the area are identified for such uses. Other primary uses are recreational, including tourism, sightseeing, hiking, trail biking, rockhounding and open space.

In 1966 the permanent population was estimated at 20,000. The percentage increase of population growth has been phenomenal since 1950. This is directly related to BLM's Small Tract program which was initiated in the 1950's. A survey conducted in the spring of 1967 in Yucca Valley, showed the average age of the residents interviewed to be 60 years, and 50 per cent were retired. In 1966, the retirement population (60+ age group) contributed about $7.5 million to the economy.

Basic industry is practically nonexistent in the valley. Urban service-type industrial uses and a few small specialty manufacturers comprise the total. The valley is dependent upon three economic resources -- tourism, the income of the permanent and weekend residents, and the economy resulting from the Marine Base.

The Twentynine Palms Marine Base and Joshua Tree National Monument were contacted by the Edison Company for possible transmission line rights-of-way. Both agencies refused to allow a right-of-way across withdrawn lands under their respective administration.

If unable to cross the Marine Base or the National Monument, line routing is limited to existing routes north of the Marine Base and south of the Monument, or to a new route, part of which crosses between the Marine Base and the Monument.

Edison Company prefers not to use the established routes citing the high risk factor of placing too many lines in single corridors, which would reduce the reliability of supplying power to Southern California. As for the route south of the Monument, Edison Company states that there is not enough room in the corridor for another 500 KV line. The corridor north of the Marine Base, besides affecting reliability, is more costly than the Company's proposal because of the greater distance involved.

Because of the restrictions caused by topography and land ownership, the possible routes for transmission lines across the California Desert in an east-west direction are limited. The possible routes are shown on Map 5. Two of the routes, and part of the third, are already established corridors.

BLM is the major landowner, administering about 65-75 per cent of the total area. In addition, there is a significant checkerboard pattern of Southern Pacific Land Company lands intermingled with public domain lands. Under the Classification and Multiple

Use Act of 1964, about 98 per cent of the public domain lands have been classified for multiple use management. The remaining public lands are located in the urbanizing and rural retreat areas as identified in San Bernardino County's General Plan.

Route A

Route A is the location that the Edison Company is considering. It is about 157 miles long. It starts at the Mohave Generating Station and extends southwesterly, crossing US 95, National Old Trails Road, and US 66, (Interstate 40). Along this portion of the route the terrain is gentle slopes with rolling hills. After crossing US 66, Route A would parallel the Santa Fe Railroad and Highway 66, extend through the Piute Mountains, and pass along the north side of Old Woman and Ship Mountains. The route would be distantly visible (4 to 5 miles) along Highway 66 and visible from the Old Woman Mountain recreation complex.

From the Ship Mountains, Route A would continue southwesterly and cross the scenic Amboy Road and on to the southeast corner of the Twentynine Palms Marine Base. The terrain along this portion of the route is generally flat with some rolling hills. It crosses a dry lake bed. The vegetation in this area is very sparse. From the southeast corner of the Marine Base the route would extend west through the Twentynine Palms, Joshua Tree, and Yucca Valley communities. The route would pass about one-half mile north and would be visible from a proposed county park near Copper Mountain, just west of Twentynine Palms.

Northwest of the community of Yucca Valley, Route A would cross California Highway 18, then turn south and cross Twentynine Palms

county road, pass through the Little San Bernardino Mountains east of Morongo Valley, and terminate at Devers Substation.

Route B

Route B would extend southwesterly from the Mohave Generating Station parallel to an existing 500 KV line. It is about 175 miles long. This route would cross US 95 and extend to a point north of Goffs. The terrain consists of gentle slopes with rolling hills. From Goffs, the route goes westerly across relatively flat desert terrain, and through the New York-Providence Mountains. These mountains have been identified as an important recreation complex in the Mohave Desert. After extending through the New York-Providence Mountains, Route B would pass north of the Granite Mountains and south of the Kelso Dunes. Both areas have significant recreation values. From this point it would go south along the western boundary of the Marine Base, passing through desert topography of gentle rolling hills, cross Old Woman Springs Road, and finally intersect alternate Route A northwest of Yucca Valley. From this point, Route B would continue and follow the same route as Route A through Morongo Valley to Devers Substation.

Yucca Valley - looking southeasterly from north side.
Joshua Tree National Monument in background.

Approximate location where alternate Routes A
and B would merge. Looking northwest.

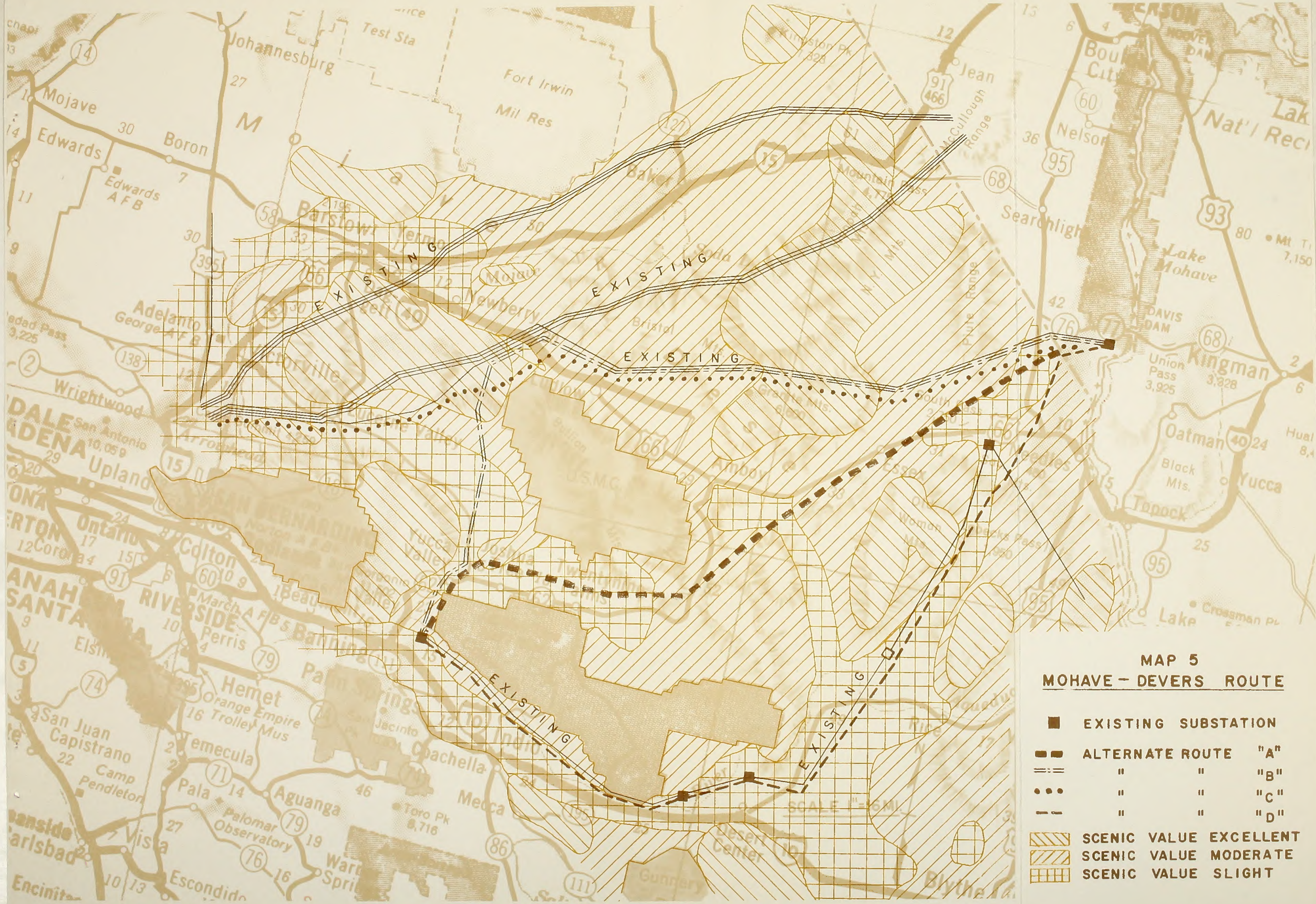
Route C

Route C, about 155 miles long, would follow the same location as Route B from the Mohave Generating Station to the northwest corner of the Twentynine Palms Marine Base. From the northwest corner of the Marine Base, Route C continues southwesterly along an existing corridor of four transmission lines. It would pass through a portion of the Rodman recreation complex, which has high scenic and recreation values. It would then pass through the Lucerne Valley north of the community. From this point it would cross Old Woman Spring Road, extend westerly through low scenic areas, missing the heavier populated areas, and extend through Antelope Valley to Cajon Pass area northwest of San Bernardino. This route would probably terminate at a substation north of Cajon Pass rather than at Devers Substation.

Route D

Route D would go in a southerly direction from the Mohave Generating Station paralleling existing transmission lines. It is about 185 miles long. The route would go west of the Sacramento Mountains, cross US 95, National Old Trails Road, and US 66. This area is typical of desert topography, with gentle slopes and rolling hills. After crossing US 66, Route D extends through Ward Valley, which is a wide sweeping valley with a moderate cover of mesquite

brush. The Stepladder and Trestle Mountains are along the east side of Ward Valley and Old Woman Mountains are on the west side. These mountains have high scenic and recreational values. At the southern portion of Ward Valley, the route would cross the Santa Fe Railroad tracks and the Rice Road. It would then continue across a dry lake bed to an existing substation northwest of Desert Center. From this point it would pass to the south of the Joshua Tree National Monument; parallel and cross Interstate 10 twice; go through sparsely populated areas and terminate at Devers Substation. This portion of the route would closely follow the Colorado River aqueduct, which supplies water to the Los Angeles Basin area.



MAP 5
MOHAVE – DEVERS ROUTE

■ EXISTING SUBSTATION

▬▬ ALTERNATE ROUTE "A"
═══ " " "B"
• • • " " "C"
— — " " "D"

▨ SCENIC VALUE EXCELLENT
▨ SCENIC VALUE MODERATE
▨ SCENIC VALUE SLIGHT

Analysis and Discussion

Economic, social, and physical patterns of our environment are rapidly changing throughout the country. The California desert is a critical environment.

Route A

Route A would create a new transmission line corridor through the California desert. If the Mohave 1 & 2 lines were located along Route A it would have the greatest impact on the desert environment of all the routes considered. The route would cross and parallel portions of US 66 and the Amboy Road (from Twentynine Palms to Amboy), identified in the California Desert Study as a scenic route. Lines within this route would be seen from the Twentynine Palms highway (a scenic route) which extends through Twentynine Palms, Joshua Tree, Yucca Valley and Morongo Valley. The line, however, would be obscured from view along this highway from about north of Joshua Tree to where it would cross the highway north of Morongo Valley and into the Little San Bernardino Mountains. It would be visible again between the Little San Bernardino Mountains and its terminal point at Devers Substation.

The most heavily used entrances to Joshua Tree National Monument are at the communities of Twentynine Palms and Joshua Tree. High

voltage transmission lines crossing through this relatively narrow valley would adversely affect the desert scene as viewed by recreationists visiting the valley and the Monument.

That portion of the line extending through the Little San Bernardino Mountains, north and east of Morongo Valley, would cross a portion of the Bighorn-Whitewater scenic recreation complex as identified in the California Desert Study.

Route B

Route B would extend westerly along an existing transmission line from the Mohave Generating Station; north of the Marine Base; then along the western boundary of the Marine Base to the same location as Route A from a point northwest of Yucca Valley to its terminal point at Devers Substation. The impact on open space and natural beauty is different along this proposed route because a corridor is already in use from the Mohave Generating Station to the northwest corner of the Marine Base. The line would extend along this existing corridor. Therefore, the increased impact of additional lines would be slight.

The proposed routing along the west side of the Marine Base would in effect establish a new corridor, and create the impact of a new intrusion on the desert scene. This part of the desert is also extensively developed for urban and rural retreat areas.

Route C

This alternate route would follow the same location as Route B to the northwest corner of the Marine Base. It would then follow existing lines to the Cajon Pass area. Because of the existing corridor, there would be little increased impact on the open space and natural beauty of the desert scene by the addition of two more lines.

If this alternative should be used, the Mohave power would probably terminate at the existing substation north of Cajon Pass instead of Devers.

Route D

Route D would extend in a southerly direction from the Mohave Generating Station to the southeast corner of Joshua Tree National Monument and then on west on the south side of the Monument to Devers Substation. This proposal would follow existing transmission lines.

Open space and natural beauty are not adversely affected by the visual impact and the effect would be slight because of the existing established corridor.

Transmission line south of Joshua Tree
National Monument, about ¼ mile
from US Highway 60 (I-10)

Same power line about 2½ to 3 miles
from US 60 (I-10)

Southern tip of Joshua Tree National Monument looking north from US 60 (I-10). Power line about one mile north of highway but cannot be seen against mountain background.

The following summarizes the estimated lengths of the four routes under consideration:

Route A	157 miles
Route B	175 miles
Route C	155 miles
Route D	185 miles

Using the indicated cost of $125,000 per mile, the estimated costs of the alternate routes are:

Route A	$19,625,000
Route B	21,875,000
Route C	19,375,000
Route D	23,125,000

Conclusions and Recommendations

Southern California Edison Company has not filed an application with BLM for a transmission line right-of-way between the Mohave Generating Station and the Devers Substation. Therefore, the study team's recommendation can only indicate at this time what appears to be the most suitable route taking into consideration the environmental impacts and system reliability. The team recommends that Route D be established as a corridor between the Mohave Generating Station and the Devers Substation and that Route C be established as a corridor between Mohave Generating Station and the Cajon Pass area.

Two routes, C and D, are in existence linking the Mohave Generating Station area with the Los Angeles Basin. Two other routes link the Eldorado Valley area with the Basin. The team recommends that all four be established as utility corridors.

If the Mohave 1 & 2 lines were located along Route A it would establish a new corridor and have the greatest impact on the desert environment of all the routes considered. Route A would also pass through a relatively narrow valley bounded on the north by the Marine Base and on the south by Joshua Tree National Monument. The valley communities and land ownership limit the width of any

corridor located through this area. It is questionable that Route A would provide more system reliability than establishing Route D as a corridor.

A portion of Route B would also pass through an area where no high voltage lines now exist. The impact on the environment at this point would be the same as that of Route A.

With widely separated routes in existence, the establishment of new Routes A and B would have an adverse environmental impact in the area and do not appear to be necessary for increased system reliability.

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